Effect of using a sauna to limit heat acclimatisation decay in cooler climates

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James Coe

Abstract

The effects of heat acclimatisation via moderate to high intensity exercise in the heat at 1-2 weeks result in lower heart rate (hr), tympanic temperature (tt), rate of perceived exertion (rpe), thermal sensation (ts) with a concurrent increase in sweat rate (sr) and sports specific performance potential. Alternative strategies such as passive heat exposure via sauna and hot water exposure; alone and in conjunction with exercise; have equally been shown to induce thermal stress adaptations and subsequence improvement in performance in cooler climates. However, heat acclimatisation is also prone to decay; reported at 2:1 days ratio away from the heat. Whilst current reported rapid acclimatisation strategies at 2-4 days upon re immersion to the heat are effective; they are not always realistic to an athlete's competitive schedule. As such, to limit the decay of prior heat acclimation, a post exercise sauna (80 degrees celsius) was implemented in contrast to exercise only in cooler conditions at 20 degrees celsius. A one-way ANCOVA to determine statistical significance in markers of performance ($p \leq 0.05$) between a post exercise sauna group (S) N=10 and exercise only (NS) N=10 males; 32.65 years old ± 3.53. residing in the middle east; whilst controlling for pre-test scores reported significance F (2,17) =.4.89, P=≤.041 in post intervention ratings of RPE; 14 (S) and 16 (NS) upon return to running outside in thermal temperatures towards 36 degrees celsius. Other markers of performance were not significant whilst controlling for pre-test scores; hr, tt, ts, sr and distance covered in a 20-minute submaximal competitive run P=≥.05; limitations linked to familiarity with running, hydration and intensity of exercise in the cool may have been confounding effects. The findings of this paper suggest a relatively simple and time effective approach in which to maintain heat acclimation during periods away from the heat for partially or fully acclimatised athletes.

Key words: thermoregulation temperature performance hydration intensity

Introduction

Literature review

Positive effects of heat acclimatisation (HA) are associated with several psychophysiological benefits such as decreased heart rate (HR), increased sweat rate (SR) and increased plasma volume alongside improved self-reported factors such as lowered rate of perceived exertion and thermal stress (11,16,22). As such, improved psychophysiological benefits may contribute to higher levels of relative sports performance in the heat. To date, a wide body of research (16,23,25,53) has focused on the most effective heat acclimatisation strategies in which to prepare subjects for sports performance in the heat. Examples of heat acclimatisation strategies are repeated bouts of low intensity high volume exercise at 60 % maximal oxygen uptake (11), exercise at high temperatures; 40 degrees within artificial heat acclimation chambers (45, 46), and isothermic clamping (55), thereby adjusting exercise intensity to ensure that a subject's core temperature remains within a prescribed temperature threshold.

Short-term heat acclimatisation protocols towards seven days are associated with significant cardiovascular responses such as decreased heart rate and increased plasma volume (16,55) whilst medium and long-term strategies at 14 days and beyond are associated with further heat adaptations such as reduced body temperature and increased sweat rate.

Success of heat acclimation strategies depend on the relative intensity, environmental conditions and duration (11,16,22,47) of a heat acclimation protocol linked to subject specific response. Examples with elite endurance athletes (1) reported that several weeks of heat acclimation training had a non-significant effect upon baseline training status. Further reported factors (46) such as ethnicity, partial heat acclimation from daily lifestyle, age and gender may also affect the relative success of heat acclimation protocols. As such the heat acclimation interventions should be carefully tailored to the subject's needs.

<u>Heat acclimation for sport performance</u>

The current world of elite sport dictates that competition can occur in several continents at one time. Athletes are therefore predisposed to cooler temperate climates and warmer climates in short spaces of time (11). Whilst heat acclimation protocols have made significant impact upon psychophysiological factors associated with sports performance (46), several of the reported heat acclimation strategies are perhaps not realistic to the relative time constraints of the modern elite athlete lifestyle. Budget and time in preseason may allow travel to warmer climates, however, during the competitive phase, there is little time to travel. Secondly, the reported heat acclimation strategies (22) involve prolonged exposure to the heat using training methods that may not be suited to a wide array of sports. Finally, several of the heat acclimation strategies employ artificial costly heat acclimation chambers. Whilst heat acclimation chambers control for relative heat dosage and humidity (22), heat acclimation chambers also equally offer little ecological validity related to sports specific training; for example, team sport drills such as agility skills in field games and running based movements in court games.

Passive heat acclimation strategies

As such, several studies have focused on the use of passive heat exposure (51,57) in conjunction with regular training routines. Passive heat exposure refers to interventions such as hot water bathing and saunas (22). Studies (51) using 6 elite 5km runners using 3 weeks of post exercise saunas at temperatures of 89.9 degrees reported a 32% increase in run time to exhaustion in comparison to a control group. Further passive heat and exercise interventions (15) have utilised a crossover design with 9 competitive male rowers using a post exercise sauna set at 84.4 degrees. After a period of 2 days there was a reported increase in plasma volume of 3.2%; however; mean power output had a deterioration of 1% in comparison to the control group over the duration of the study. Short- term repeated measure studies (44) have focused on a 30-minute bike aerobic test on day 1; with subsequent passive rest at room temperature set at 20 degrees. The repeated measure involved the same exercise protocol but with passive rest in a sauna at 90 degrees. Results confirmed sauna exposure reduced oxidative stress induced by the 30-minute bike aerobic exercise in contrast to passive room temperature rest alone. Whilst passive heat exposure in conjunction with regular exercise routines appear somewhat effective, further research is required with regards to the methodology of passive exposure for maximal benefit. Thermoregulatory stress associated with sauna exposure alone is reported with exposure to 10 sauna sessions set at 90 degrees (24). Results confirmed positive effects on blood plasma volume; like which may be seen in moderate intensity exercise. Therefore; prolonged passive heat exposure at too high a frequency may not allow adequate recovery time and subsequent decrements in athletic performance.

Decay of heat acclimation

A further significance in establishing effective heat acclimation strategies for elite sport is related to the subsequent decay of heat acclimation upon cessation of heat acclimation interventions. Currently there is conflicting evidence (11,16,22,45) with regards to the time course of heat acclimation and associated psychophysiological benefits. Several reports (16) confirm that the effects of heat acclimation may last as towards 28 days, whilst other reports (22) suggest that the time course of heat acclimation adaptation is relatively short with effects of decay reported at 2-4 days. As such, current guidelines (11,16,22,42) suggest that the rate of heat acclimation decay is at a ratio of 2:1 days with respect to time away from the heat. Either way, the first adaptations of heat acclimation; cardiovascular adaptations; are equally the first to decay (16), whilst secondary adaptations; sweat rate and body temperature are more resilient to decay (11,45).

To limit the rate of heat acclimatisation decay, studies (16) have focused upon the length of time to reacclimatise using repeated heat acclimation strategies (55) as in the initial acclimation stage. Results thus far (11,16) suggest that subjects can reacclimatise effectively over the duration of only a few days. Furthermore, maintaining exercise during time away from the heat has been highlighted (22,45) as an effective intervention to limit the loss of heat acclimation decay. Reports (16,22) using only moderate intensity exercise at 45% maximal oxygen uptake identified no change in the rate of perceived exertion and thermal perception in the heat at towards 18 days since the last exposure to the heat.

Relative fitness levels have also been associated with less heat acclimation decay. Studies (43) focusing on the heat acclimation of soldiers reported a strong association between higher maximal oxygen uptake and slower rates of decay with prior heat acclimation linked to lowered heart rate during exercise in the heat at towards 20 days.

Conclusion

However, with respect to the endeavors of real world athletic performance, the reported strategies linked to rapid recacclimation to maintain the positive effects of prior heat acclimation may not always be feasible. Recall, athletes are time crunched thereby schedules may not allow periods of somewhat aggressive reacclimation strategies. Secondly athlete specific training routines may be contravened by prolonged reacclimation heat interventions.

As such, a strategy that would encompass the minimum exposure to heat whilst allowing continued athletic endeavor would be ideal for real world athletic performance (11).

Whilst the reported passive heat exposure strategies have shown somewhat positive results under the duress of routine training, it may be noted that all the passive heat strategies to date have only focused on the effects of exercise in temperate conditions. To date, no studies have focused upon the effect of passive heat exposure specifically linked to sauna exposure with performance in the heat (25).

Hypothesis

With respect to maintaining athlete heat acclimation throughout the course of a season, sports specific training in conjunction with post exercise passive sauna bathing may provide a simple and more effective strategy rather than current suggested athlete re-acclimatisation protocols. The merits of such research would be to establish the minimum disruption to training and an identified minimum exposure to heat athletes may need to assist in the maintenance of performance in a range of temperate conditions.

The null hypothesis is that there will be no significance difference between the adjusted means in markers of performance following routine exercise in cooler climates in comparison to routine exercise with post exercise sauna exposure in cooler climates.

Alternatively, there will be a significance between the adjusted means in markers of performance in comparing routine exercise only with routine exercise with a post exercise sauna.

Methodology

Experimental approach to the problem

A two way between groups design was employed with control of pre-intervention scores to test for significance in adjusted means of heart rate, sweat rate, tympanic temperature, rate of perceived exertion, thermal sensation and distance covered in a 20-minute time trial run. Participants were randomly selected to participate in an exercise only group or exercise and post exercise sauna group. A G power sample calculation was made prior to the recruitment of participants based upon a F test one-way ANCOVA to test for fixed effects, main effect and interactions between the groups. A Cohen's D large effect size 1.20 was selected, significance was set at 0.05 for a total of 25 participants across two groups. One covariate was set; the pre -test baseline measures.

Subjects

Pre-study approval was attained by St Mary's University Twickenham London ethics approval board at level 3. Before participating in the study all participants were presented with a par-q form and a consent form informing them that they had the right to withdraw at any time with no reason. 24 participants were recruited for the study in line with the G-power sample for significance at 0.05; Cohen's effect size 1.20. However, 4 participants withdrew from the study due to unexpected work commitments. The remaining 20 participants were all male aged 32.65 ± 3.53, weight 81.38±12.2. All participants were all recreationally active in team and individual sport and routinely exercised and coached outside toward several times a week. As studies suggest (25) the habitational habits of all participants in middle eastern hotter climates suggest that partial heat acclimation would be present. All subjects were healthy, non-smokers and competing in a variety of recreational team and individual sports that all involved the ability to run for prolonged periods of time.

Table 1: Study participants ethnicity and sports

Gym Sauna	Ethnicity	Sport	Gym	Ethnicity	Sport
1	Irish	Triathlon	1	German	Triathlon
2	Asian	Soccer	2	English	Crossfit
3	Arabic	Soccer	3	Scottish	Soccer
4	English	Soccer	4	Arabic	Gym
5	African	Crossfit	5	Irish	Running
6	English	Soccer	6	English	Soccer
7	English	Soccer	7	English	Soccer
8	English	Soccer	8	English	Soccer
9	American	Running	9	Irish	Gaelic Ft
10	English	Soccer	10	Indian	Gym

<u>Procedures</u>

Physiological measurements were recorded as follows; heart rate: x 3 Polar A300 heart rate monitors that was mounted around the torso throughout the duration of all outdoor and indoor runs. Heart rate was 'fed back' via the Polar A300 wrist watch. Tympanic temperature was recorded at the earlobe via a one OMRON Gentle Temp 520 at periods of 5-7 minutes outside and regular 5-minute intervals indoors. Pre and post run bodyweight were recorded (participants shorts only; towel dried to eradicate sweat) via a set of digital Terraillon bodyweight scales.

Perceived exertion scales were measured as follows; A Borg Scale of Rate of Perceived Exertion (10); thermal sensation was recorded via an ASHRAE 7-point thermal sensation scale (7).

Gym based, and health suite-based equipment consisted of a Technogym Jog 700 treadmill, an Accusplit Pro Survivor Stop watch and a TYLO dry heat sauna with thermostat control at 80 degrees centigrade.

The study took place over a duration of two months; March-April; in the hotter temperate climates of the United Arab Emirates. Average outside temperatures ranged from 28 -36 degrees Celsius with varying levels of humidity. Exposure to cooler climates took place in a temperature controlled commercial gymnasium set at 20 degrees Celsius.

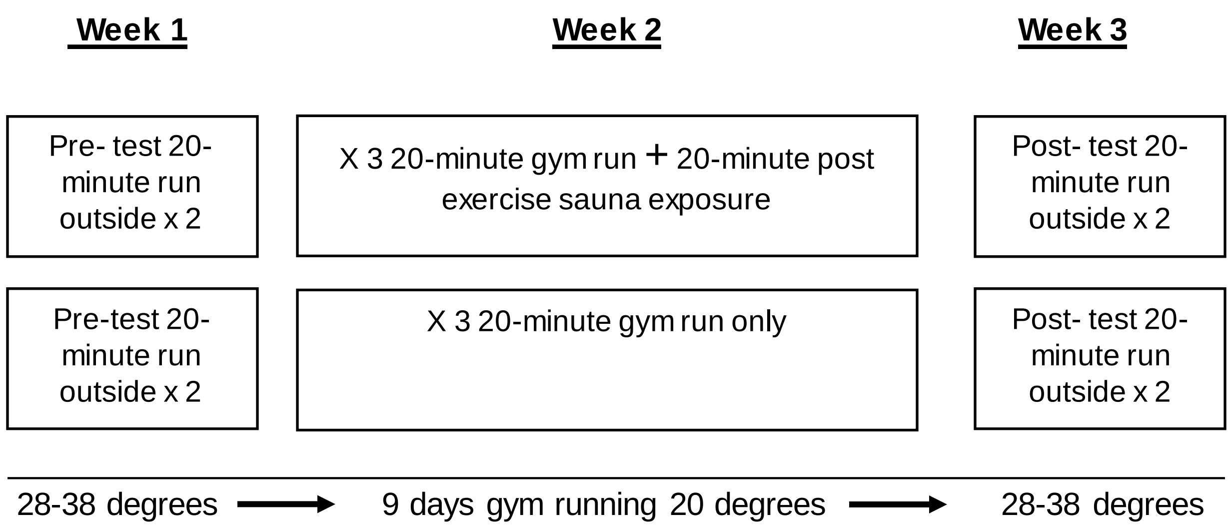


Figure 1: Study Protocol

All participants took part in two 20-minute runs during week 1 separated by two days, during early to mid afternoon. Pre-test baseline scores were taken with respect to heart rate, tympanic temperature, sweat rate, thermal sensation, rate of perceived exertion and distance covered in the 20-minute duration. During the 9 days in the indoor training only condition, participants only outdoor activity was work based; observation of students in physical education lessons.

Heart rate was taken from the reading on an A300 polar HR monitor watch, tympanic temperature protocol required following manufacturing guidelines with regards to clean probes and gentle insertion into the ear drum. The probe was removed upon the sound of an electronic beep to signify measurement had been recorded. Sweat rate was recorded via nearly nude body weight measurements pre and post run, rating of perceived exertion and thermal sensation were taken upon cessation of the run. Distance was noted via laps completed outside (one lap 1.3km) and recorded distance via the treadmill when in the gym. Physiological baseline measurement readings were taken sporadically throughout the 20-minute run at intervals of 4-6 minutes. To allow for intermittent baseline readings during the outdoor run, subjects ran around an allocated circuit with a total distance of 1300 meters as measured by a Zeopoxa Cycling Bike Tracker Application from Google play store. Participants wore normal training attire and were instructed to only drink before and after the run so that sweat rate could be accounted for without fluid consumption. A twenty-minute run was chosen as previous studies with post exercise sauna exposure have focused on 15-minute time trial-based running (51) at high intensity or runs for longer duration (57) at 40 minutes; albeit with lower intensity. As such, the 20-minute run in the current study represented a similar protocol to past post exercise sauna studies. In the current study, participants were informed to run as far as they could for the duration of 20 minutes. This was to induce a competitive element to the study and match real world scenarios with respect to athlete expectations in the competitive season.

Secondly, as all participants were required to only train inside for a period of 9 days; several participants had to drop the volume of regular training; as such a higher intensity was maintained to account for differences.

Upon completion of week 1 participants, were randomly allocated to either a non-sauna (NS) or sauna (S) group, based on lack of significance in pre-intervention running times. Participants were informed that for a period of 9 days; that encompassed week 2; they were to exercise inside only and refrain from any sports play outside. However, normal daily work activities and diet remained the same.

During week 2 participants completed three 20-minute treadmill runs with the same instructed intensity upon a treadmill set at a gradient of 1%. A gradient setting of 1% was employed in line with previous studies (28) that report a relationship between running velocity at 2.92-5.0 meters per second outside over a period of 5 minutes and a treadmill gradient of 1%. The 1% gradient setting was important in the current study to maintain reasonable consistency between the demands of outdoor running and indoor running throughout the course of data collection. Participants in the S group entered the dry heat sauna set at 80 degrees upon cessation of their run. As in week 1, heart rate, sweat rate, tympanic temperature, perceived exertion and thermal sensation measurements were taken; albeit with a tighter interval control period of 5 minutes. Measurements of tympanic temperature and heart rate were also taken at regular interval periods of 5 minutes of from participants in the sauna intervention. During exposure to the sauna participants could drink ab libitum for health and safety reasons. Sweat rate was only recorded via pre and post running measurements rather than after immersion into the sauna.

On re exposure to exercise in the heat at the beginning of week 3, participants ran the same running course and were instructed to complete the furthest distance as possible in 20 minutes. Of importance was the duration of time between the last exercise only and exercise with a post sauna session before the post testing in week 3. All participants had an interval of a maximum of 3 days between the last indoor intervention training session and re exposure to the heat in week 3. As such, the duration of training in cooler climates was a consistent 9 days, this was to strengthen the experimental design. Previous authors (55) report that too short a time (3-4 days) between the last exposure to exercise in the heat and re exposure may constitute a training adaptation stimulus and as such a confounding variable to the decay of markers of performance whilst training in the heat. This is particularly prevalent in attempting to establish the efficacy of a post exercise sauna intervention compared to exercise only.

As in week 1 and 2 all markers of performance; heart rate; tympanic measurement, sweat rate, perceived exertion scales were taken at regular intervals. Distance was recorded upon cessation of the run.

Statistical analysis

Statistical analysis was performed using IBM SPSS 24, a one- way ANCOVA was conducted to compare the significance of using a sauna in conjunction with exercise in the cooler climates against exercise only whilst controlling for pre- test mean values. Levene's test and normality checks were carried out and assumptions were met.

Results

Interaction between pretest performance variables

A One-way ANOVA and homogeneity of regression confirmed there was no difference in the pre-test scores between or within the NS and S groups.

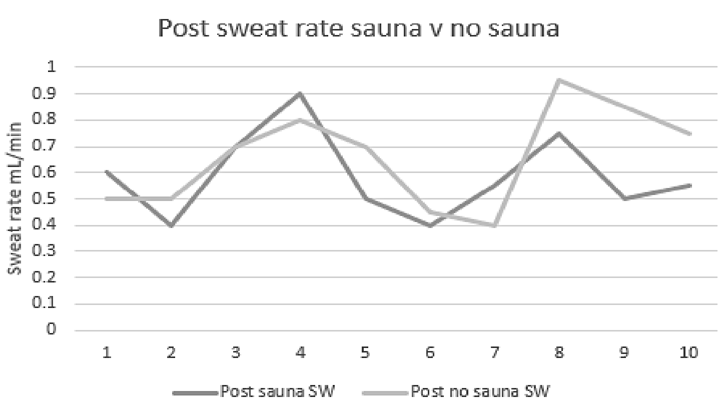
Table 2: Non-significant interaction across groups in the pre-test

Performance Variable	**Sauna Pre- test**	**No Sauna pretest**	**Sig btw gr/between btw ps**
	Mean	Mean	Significance P=0.05
Heart Rate Bpm	168.5	174.3	.231/.223
Tympanic temperature Celsius	36	36.14	.630/.296
Sweat Rate mL/min	0.51	0.59	.400/.551
RPE	15.05	15.1	.953/.565
Thermal Sensation	0	1.06	.570/.204
Distance km	3930.5	4037.5	.652/.915

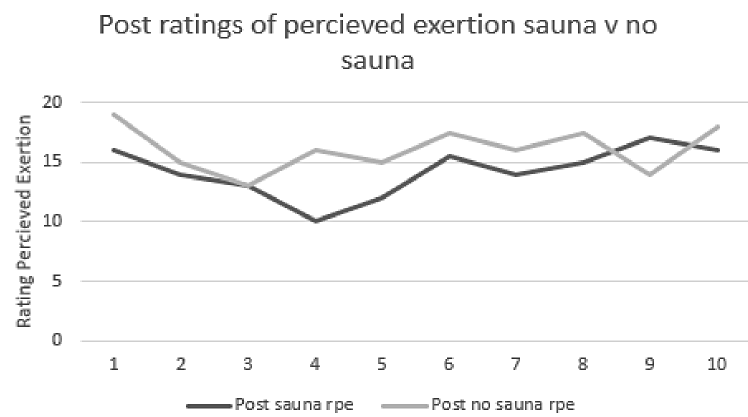
Markers of performance after 9 days training in the cool

A one-way ANCOVA confirmed a significance group differences for RPE scores $F\ (2, 17) = 4.89$, $P \le .05$**,** after controlling for pre-test scores. Group differences for heart rate $F\ (2, 17) = .701$, $P \ge .05$, tympanic temperature; $F\ (2, 17) = .470$, $P \ge .05$, sweat rate; $F\ (2, 17)$

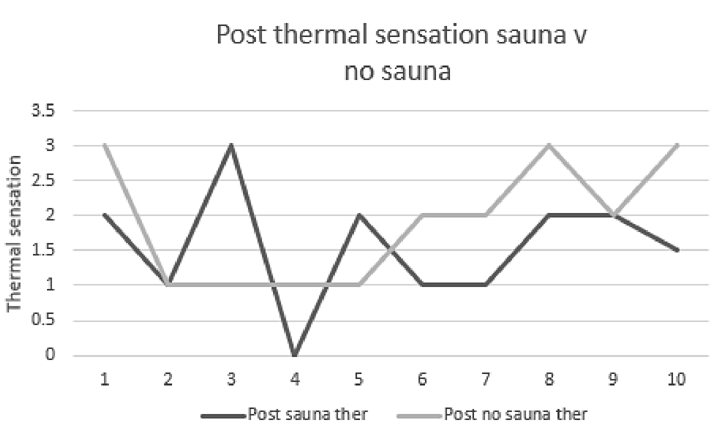
=.562, P≥.05, thermal sensation; F (2, 17) =.500, P≥.05 and distance covered F (2, 17) =.454, P≥.05 were non-significant after controlling for pre-test scores.



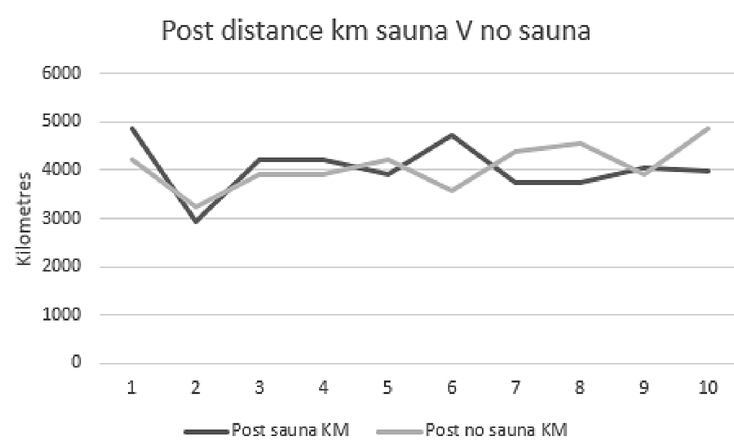
F (2,17) =.562, P=≥.05



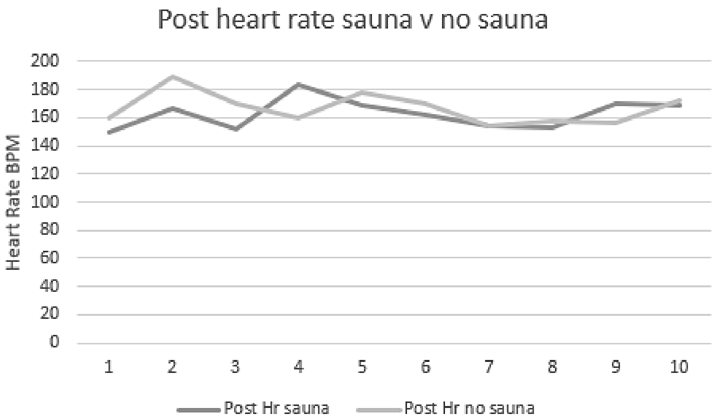
F (2,17) =.4.89, P=≤.05*

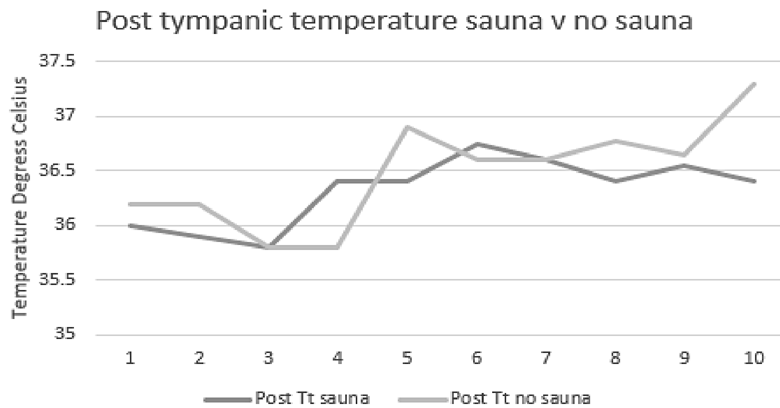


F (2,17) =.500, P=≥.05



F (2,17) =.454, P=≥.05





F (2,17) =.701, P=≥.05

F (2,17) =.470, P=≥.05

Figure 2: Markers of performance after 9 training days in cooler climates

Post intervention values between sauna and non-sauna groups

Table 3: Mean post intervention values sauna v non-sauna group

Performance variable	Post sauna mean/stdv	Post no sauna mean/stdv
Heart rate bpm	163.075/ 13.43 ±	166.725/ 8.48 ±
Tympanic temperature C	36.4/ 0.28 ±	37.3/ 0.77 ±
Sweat rate mL/min	0.58 / 0.035 ±	0.66 / 0.17 ±
*RPE	14.25 / 0 ±	16.1/ 0.70 ±
Thermal sensation	1.55 /0.35 ±	1.9 /0 ±
Distance KM	4039.75/ 620.4 ±	4078/459.61 ±

=Significant P=≤.05

Discussion

Significance of a post exercise sauna to limit heat acclimation decay

The aim of the current study was to elicit as to whether a post exercise sauna during exercise in cooler conditions helped to limit the decay of several markers of performance on return to the hotter climates. The only established significance (P=≤0.05) was the RPE between the experimental and control group. As such, the null hypothesis is rejected and the alternative hypothesis retained. Although this finding appears to be somewhat limiting, it does corroborate with the several past reports (1, 14, 21, 26, 40, 42, 54) with reference to the significance of the rate of perceived exertion as a modulator of exertion in the heat.

Rate of perceived exertion

Previously (54) non acclimatised trained cyclists (N=8) under the proviso of self-paced exercise; with a designated RPE scale 16 clamp; reported a faster rate of decline in work output in the heat, in contrast to cyclists in cooler conditions with the same designated RPE scale 16 clamp. Further self-paced studies (1) with a focus on power output and muscle activation over the duration of 100km cycling time trial, report muscle power output impairment in the heat compared to the cool prior to a rise in core temperature.

Together these studies suggest that the significance of RPE in the heat may work as a moderator of energy expenditure via a feedforward system (21,26,40) to preserve physiological homeostasis when working the heat, and thereby limit resultant critical damage from heat stress. The significance of a feedforward system with respect to exercise in the heat prior to performance may result in a pre-conceived moderation of work output to effectively maintain intensity based on initial perceptions of the heat. Whilst (1) argue that RPE may not be a thermal regulator, as thermal sensation was more closely associated with a decline in power, further reports (17, 36) highlight a potential thermal control mechanism of RPE via the attainment of lower levels of maximal lactate accumulation in the heat (17), and disassociation of higher levels of RPE and lower levels of lactate upon cessation of exercise in the heat respectively. As such, the studies (17,36) suggest that work output in the heat maybe disrupted via sensory feedback prior to, or during performance and thus limiting the rate of work output; regardless of physiological capacity. With respect to the current study whilst there was no significance (P=≥.05) different in the total running distance (km) covered during the 20-minute time trial between the experimental and control group at pre or post study intervention; upon subsequent return to the heat, the gap between the experimental group and control group had gained a mean distance of 68 meters; thereby decreasing the pre-study intervention gap from 107 to 39 meters.

Further underlying mechanisms for the significant difference in the RPE and the somewhat marginal running performance gain may have been attributed to differences skin temperature and sensation of heat. Whilst skin temperature was not measured in the current study; initial differences in skin temperature may have influenced RPE. Skin temperature control (4) via pre 5km running ice vest cooling has elicited significant differences to 5km running performance at the midway stage. Furthermore, perceived intensity via peripheral thermal stimuli (38) is reported to effect subsequence ratings of likely thermal stress; regardless of core temperature. Identified perceptions of potential thermal heat stress, regardless of a rise in core temperature (14, 40, 42) note that the RPE may be different at the start of exercise and thereby continue to dictate pacing strategies and subsequence performance going forward. From a functional anatomical perspective, affrent feedback prior to or during early performance with respect perceptions of discomfort have been identified (14, 42) to be linked to the lamina 1 spinothalamocortical system; and thus, a detection of thermoregulatory stress and subsequent performance decrements. Pre-exercise thermal stress (skin temperature 35 degrees in heat v skin temperature 30 degrees in cool) has been shown (3) to display levels of lower power outputs (-20watts) via competitive cyclists in 4km time trailing with a disassociation of cardiorespiratory strain. With respect to pacing strategies during short cycling time trials towards; 15km (31, 32) radiant heating over the duration of longer duration time trial efforts decreased total mean power output; with no significance in rectal temperature or cardiorespiratory variables between cool and hot conditions. With respect to intermittent exercise; perceptual strain (RPE; $P=\leq 0.01$) amongst non-acclimatised tennis players (46) during match play in the heat in contrast to the cool significantly increased time between points and overall duration of match play.

Therefore, importance of significant differences in rating of perceived exertion between the sauna and non-sauna group in the current study is linked to the premise to establish more feasible real-world interventions that may contribute to maintaining athlete performance levels across an array of environmental conditions. As such, the smallest contributor to performance may assist in eradicating performance decrements on return to the heat.

Past studies confirm (16,25,43) that the maintenance of exercise in cooler conditions can help to prevent the rate of heat decay via the maintenance of thermoregulatory heat responses linked to cardiac stability and fluid dynamics (33). Of wider interest with the current findings is the notion of the potential added benefit of brief exposure (20 minutes) of passive post exercise saunas alongside routine exercise in the cool. All the subjects in the current study were informed to maintain a time trial-based intensity for the duration of a 20-minute run whilst outdoors and inside. As such, the experimental design invoked competition like conditions inducing sub maximal effort from participants during data collection. Therefore, considering the lack of significance between pre-test group means, and the submaximal 20-minute running efforts by all participants, the significant impact of differences of rates of perceived exertion perhaps holds more ecological validity in contrast to previous studies as follows. Previous strategies (16) have used controlled lower intensities at 60% maximal oxygen uptake to test for rates of heat acclimation decay, or alternatively have employed prolonged artificial laboratory conditions (45) to re acclimatise after periods in the cool before return to the heat. Whilst significance has been reported (16,46,47), many of the strategies are not suited to time crunched real-world scenarios of athlete demands.

Secondly, the current study was short (14 days) and with relative minimal sauna exposure across the intervention week (3 x 20-minute post exercise saunas). This contrasts with previous post exercise passive heat immersion studies (57) that have reported several significant differences across markers of performance; $P \leq 0.01$ heart rate; $P \leq 0.05$ lower resting rectal temperature, final exercise temperature, onset of sweating and lower ratings of perceived exertion. However, the methodology in the noted study (57) employed 40 minutes of running at 65% maximal oxygen uptake followed by 40 minutes of hot water immersion. Taken together, this is a lengthy protocol, not realistic to usual athletic training programmes. Furthermore, the 17 male participants in the study were non acclimatised, and reportedly had not been physically active for a duration of 3 months before the start of the study. In contrast, all participants in the current study were physically active and were likely partially acclimatised due to residing and taking part in routine physical activity in hotter climates. The importance of natural heat acclimation (11,53) allows subjects to readily adjust between seasons. Therefore, the significance of enhanced ratings of perceived rate of exertion with local partially acclimated subjects after only a short period away from the heat may hold even more significant with lesser acclimatised subjects.

Environmental cross tolerance from heat exposure

The lack of significance between sweat rates and tympanic temperature between the sauna and non-sauna group concours with previous literature (16,22) in that the decay of each is robust and is reportedly unchanged at towards 18 days after heat exposure with active subjects. However, whilst gym intervention phase of the current study-maintained levels of high intensity running, to illicit regular sports performance training; conversely this is also a limitation of the study. The gym temperature was set at a regulated 20 degrees; however, lack of ventilation resulted in tympanic temperatures reading akin to outside; whilst sweat rates remained largely the same across trials due to limited evaporation in the gym environment. Lack of airflow and subsequent heat potential heat stress has been associated with hypohydration and higher skin temperatures (27,49). Given that the participants were not all regular runners, and notably not entirely used to regular treadmill running, the potential isothermic strain in the gym environment may had an increased ergogenic effect via increase in heat shock proteins (HSP72/HSP90) (2,39) which are associated with linear increments during the timeline of regular heat acclimation (19). However, given that all the participants completed the same treadmill intervention, the post exercise sauna remains as a significant independent potential mediating variable. As such comparisons may be drawn between hypoxia acclimation and heat acclimation. The concept of live high and train low for performance benefits is well reported (35) however, for many it is not an accessible protocol. Recent reports (19,30) consider a cross tolerance effect from heat studies to induce increased performance during hypoxia. Notably heat induced increments in HSP72 and HP90 have been associated with hypoxia induced factor 1 (HIF-1) which in turn increases sweating, induced vasodilation, skin blood flow and increased capillarisation. Currently heat shock proteins have been shown to be increased towards 48 hours upon cessation of hypoxic stimuli (30). Of interest with the current study protocol is a means to not only use post exercise sauna interventions to limit the decay of markers of performance in the heat; but a potential suitable strategy to maintain resilience to hypoxia conditions; given the effect of thermoregulatory heat stress on the increase in HSP72. Future directions may consider the intensity of the exercise prior to sauna exposure for enhanced results and control of requisite temperature during sauna exposure. Notably, the current study did not control for sauna temperature with respect participants temperature. This was not a possibility during the study due to the commercial facility the sauna was based in. However, via tympanic measurement all participants in the post exercise sauna attained recordings of 37 C+ with reports (13) that external temperatures are towards 1^{o}C lower than internal (rectal, oral) temperature measurements. Future endeavors should consider the effect of post exercise sauna temperature; participant temperature thresholds and subsequent ergogenic benefits; however, health and safety control would be paramount given reported altered hemodynamic induced dry sauna changes after one dry heat sauna exposure towards 6 hours post sauna (56).

Influence of hydration

Further limitations are linked to hydration status throughout the course of the study. There was no direct control over the amount or quality of consumption of fluids surrounding the gym training intervention period. Fluid regulatory strain on the cardiorespiratory system during exercise is associated with reduced cardiac output and potential thermoregulatory benefits (2,23) which may have corroborated running performance during each running trail in the study. Conversely short-term exercise acclimation with permissive dehydration is reported to potentially increase plasma volume (23, 39) which in turn aids splanchnic circulation and thermoregulation during heat stress. However, given that all participants bodyweight remained within 1-2% across all participants throughout the duration of the study, it is assumed that hydration was maintained.

Effect of training status and group heterogeneity

Reports highlight that training status, prior heat acclimation, ethnic background and age may also contribute to the rate of decay of sweat rate and core temperature. In the current study the mean age was 34 ± 3.53 whilst the heterogeneity of the group was varied via ethnic background and sports specific endeavors. Several of the participants had resided in the United Arab Emirates all their life and were not unaccustomed to exercising in temperatures over 40^{o}Cin the summer months. Secondly, participants from European descent had lived in hotter climates for at least 10 months and worked in the physically active jobs such as sports coaches and teachers. As such, the non-significant change in post intervention sweat rate or tympanic temperature may account for lifestyle factors. With reference to a meta-analysis of studies (16) reports highlight scattered results with the decay of sweat rate and core temperature which might reflect the duration of exposure to heat and the rigidity of sweat rate and core temperature.

Methodological limitations

With regards to the efficacy of employing tympanic temperature as means to record core temperature, criticisms (13) have focused upon the unreliability of the infrared probe (13) and the hand ability of the tester. However, the American Society for Testing Materials (ASTM) report that tympanic temperature thermometers fall within +/- of the error allowed for temperatures below 36^{o}C, at 37^{o}C degrees the tympanic measuring devices were within ATSM margins, whilst at 38 degrees + tympanic measuring devices were associated with the underestimation. In the current study the consistent outdoor temperatures were within the range of 28-36 degrees, whilst in-between measurements, the tympanic measuring device was kept in an air-conditioned bathroom adjacent to the delegated running area. In cooler climates within the gym, the temperature was a consistent 20 degrees, whilst measurements of tympanic temperature in the health suite (sauna area) also maintained a consistent 20 degrees via thermostatically controlled air conditioning. Finally, whilst the researcher was initially a novice to tympanic temperature measurements, technique improved. Taken together the environment was well controlled and the subsequent pre and post intervention results are viewed with confidence.

The decision to base a 20-minute running time trial protocol was based on the decision to map the current study design to previous post exercise passive heat interventions (51,57) that had facilitated runs from 15 – 40 minutes at high to moderate intensity respectively. Results confirm a non-significant difference in post intervention running performance between the sauna and non-sauna groups with a concurrent non-significant difference in post intervention mean exercise heart values. This does not concur with previous findings (6,11,16,25) that largely report a lower heart rate upon exposure to sauna due to short term increases in plasma volume (25).

As such a considered limitation of the current study is the choice of a running protocol due to the highlighted heterogeneity of participants with respect to running experience. Both groups improved mean running distance and experienced lower heart rate from pre to post study measurements which may have been linked to psychophysiological factors such as pacing strategies (8), and the participants perception (9) of running outside in comparison to indoors. A further considered limitation is the lack of control of humidity during the outside running conditions. Whilst high humidity was not present during the study, variability in humidity would have existed; with potential effect on skin evaporation and subsequent markers of performance (2,33).

Reports (8,18,33) confirm that seasoned runners (of which there were several in the study) may have had a seasoned pacing strategy which may be linked to an inverted U-shaped curve (33). As such, it has been highlighted that seasoned runners start the first 400 m of a distance race more quickly; thereby relying on sense of perceived exertion; a reported (33) 72% amongst experienced 28 male long-distance runners; within the first 400m to monitor pace. The subjects in the current study completed the outdoor and indoor runs in groups, as such non-seasoned runners may have started too quickly for the pre-testing runs; influenced by the pacing strategies of more experienced runners. Observations from the researcher noted that during the pre-testing baseline runs, several subjects needed to rapidly slow down during a lap; likely due to the onset of early fatigue. This is supported with the notion of efferent feedback via the motor sensory system (33) that may be limited in the first 400m of an endurance event. As such, during the study, less experienced runners may have acquired a better pacing strategy through the course of the study; subsequently resulting in a lower mean heart rate and distance covered; regardless of the which group they had randomly been assigned upon cessation of the study.

Furthermore, whilst the current study ensured that all participants ran outdoors and indoors; with a gradient 1% control for the treadmill; reports (9,29) confirm sensations of anxiety with respect to indoor treadmill running conditions in contrast to outdoors. Current researcher observations made note of several subject's distaste with respect to treadmill running. Secondly, several of the participants from team sports and triathlon background were largely unaccustomed to treadmill running which may have limited the area of running focus (29) with related experience of unpleasant emotions throughout the run and subsequent effects on pacing and performance. In turn, this may have affected the efficacy of the indoor based training intervention for some participants and consequence positive or negative adaptations reflected in post intervention mean distance and heart rate values. Furthermore, studies (41) on fatigue and pacing during 5km runs has reported that less experienced runners show no signs of fatigue related to sprint and power-based activities; even after the onset of fatigue during 5km. Therefore, the team sports and gym-based subjects in the current study may have equally maintained or improved performance solely due to acquired pacing strategies and improved running economy; regardless of the post sauna intervention or running based alone group.

As such, a better study design with respect to the heterogeneity of the group would have been to employ a whole-body endurance-based circuit incorporating sprint and bodyweight movements; both of which may have been completed indoors and outside. Intensity could be controlled by time to ensure a RAMP effect to exercise. Alternatively; and for future consideration; less heterogeneity amongst participants would have been ideal with respect to routine physical activities.

Finally, whilst there was a significance difference between feelings of rate of perceived exertion amongst between the groups, thermal sensation had no significance. However, given that the running duration was only 20 minutes, several reports (31,32,54) highlight the timeline of heat induced participants responses to be an important variable. It is plausible that a rise in skin temperature and feelings of discomfort manifest without a rise in core temperature and subsequent progressive thermal stress and sensation during short term exercise in the heat. However, exact timeline thresholds may depend on exercise intensity and the severity of the heat stress.

Focus (52,50) upon the efficacy of the ASHRAE 7 -point thermal sensation scale report that currently, whilst it is predominately used to attain perceptual feelings of heat; many subjects may respond to according to what they feel a favorable response should be; in contrast to what they really feel. (52) reported that in attaining the thermal sensation of 313 office workers sporadically through the day, 36% of responders felt that neutral was a not a desirable answer; that only a feeling of hot or cold should be reported. Secondly (50) report that the linearity of the scale may be questioned with respect to responder's different perceptions of what constitutes, warm, neutral, hot etc. Observations from the researcher throughout the current study report similar findings in that ethnicity (northern hemisphere v middle east and Asian subjects) and previous personal experience appeared to effect responses. In turn, actual physical temperature and thermal sensation may not be relative towards the end of the scale. However, prior to the intervention of the thermal scale the researcher had spent considered time in explaining the meaning of each definition; a better approach may be to attain feelings of thermal comfort (50).

Practical applications

The current study reports a significance effect of a post exercise sauna on subsequent feelings of the rate of perceived exertion upon return to the heat. The implications of this research suggest that partially acclimatised or fully acclimatised athletes who are largely time pressed may be able to include a post exercise sauna alongside their regular training routine to assistance in the psychological and perhaps physiological readiness for return to hotter climates. Given the associated increase in HSP72 under thermal stress and associated cross tolerance to hypoxia conditions, a post exercise sauna intervention may equally serve as maintance strategy to limit hypoxia acclimation decay. This research is useful for a wide array of athletes who may be constrained by budget and travel as saunas are generally easily accessible to the public at a minimal cost. The research also serves to suggest a mimumum intervention that may be needed to support prior heat acclimation. The current study only employed a total of one hour of post exercise passive dry heat sauna exposure throughout the course of a week. Frequency was on intermittent days, subjects did not report signs of fatigue from any overload of post exercise sauna exposure. Whilst other markers of performance in the current study were non-significant between the sauna and non-sauna groups; it must be noted that the participants in the study were not elite athletes and had a wide heterogeneity with respect to ethnic background and current physical endeavor. Furthermore, lifestyle, nutritional and hydration factors were unaccounted for, and participants were not completely removed from thermal stress due to lack of ventilation and exercise intensity in the cooler environments. Future directions for the field of research may now focus on select groups with similar physiological sporting backgrounds, further control over the identified limitations in this study to determine if a post exercise sauna for partially of fully acclimatised subjects has a further significant effect upon maintaining markers of physical performance.

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Appendices

Approved Study Ethical Approval Form

St Mary's University Twickenham London

Ethics Application Form

1) Name of proposer(s)	James Coe
2) St Mary's email address	145555@stmarys.ac.uk
3) Name of supervisor	Mark Waldron

4) Title of project: Effect of using a sauna to limit heat acclimatisation decay in cooler climates

5) School or service	School of Sport, Health and Applied Science
6) Programme (whether undergraduate, postgraduate taught or postgraduate research)	Postgraduate taught
7) Type of activity/research (staff/undergraduate student/postgraduate student)	Postgraduate student

8) Confidentiality	
Will all information remain confidential in line with the Data Protection Act 1998?	**YES**/NO

9) Consent	
Will written informed consent be obtained from all participants/participants' representatives?	**YES**/NO

10) Pre-approved protocol	
Has the protocol been approved by the Ethics Sub-Committee under a generic application?	YES/NO/**Not applicable** Date of approval:

11) Approval from another Ethics Committee	
a) Will the research require approval by an ethics committee external to St Mary's University?	YES/**NO**/Not applicable
b) Are you working with persons under 18 years of age or vulnerable adults?	YES/ **NO**

12) Identifiable risks Heat and dehydration effects of post exercise sauna intervention	
a) Is there significant potential for physical or psychological discomfort, harm, stress or burden to participants?	**YES**/NO
b) Are participants over 65 years of age?	YES/**NO**
c) Do participants have limited ability to give voluntary consent? This could include cognitively impaired persons, prisoners, persons with a chronic physical or mental condition, or those who live in or are connected to an institutional environment.	YES/**NO**
d) Are any invasive techniques involved? And/or the collection of body fluids or tissue?	YES/**NO**
e) Is an extensive degree of exercise or physical exertion involved?	**YES**/NO

f) Is there manipulation of cognitive or affective human responses which could cause stress or anxiety?	YES/**NO**
g) Are drugs or other substances (including liquid and food additives) to be administered?	YES/**NO**
h) Will deception of participants be used in a way which might cause distress, or might reasonably affect their willingness to participate in the research? For example, misleading participants on the purpose of the research, by giving them false information.	YES**/NO**
i) Will highly personal, intimate or other private and confidential information be sought? For example sexual preferences.	YES/**NO**
j) Will payment be made to participants? This can include costs for expenses or time.	YES/**NO** If yes, please provide details
k) Could the relationship between the researcher/ supervisor and the participant be such that a participant might feel pressurised to take part?	YES/ **NO**
l) Are you working under the remit of the Human Tissue Act 2004?	YES/ **NO**

13) Proposed start and completion date

Start: February 16th, 2018

Submission deadline 8th December: research to start 8 weeks after

Timetable for data collection

Date	Data collection: Scattered over week
February 16th-March 16th	12-15 participants
March-16th-April 28th	12-15
8 -10 weeks	26-30 participants

Completion: April 28th 2018

Please indicate:

- When the study is due to commence.
- Timetable for data collection.
- The expected date of completion.

Please ensure that your start date is at least 4 weeks after the submission deadline for the Ethics Sub-Committee meeting.

14)Sponsors/Collaborators
Please give names and details of sponsors or collaborators on the project. This does not include your supervisor(s) or St Mary's University. • Sponsor: An individual or organisation who provides financial resources or some other support for a project. • Collaborator: An individual or organisation who works on the project as a recognised contributor by providing advice, data or another form of support.
Sponsor=N/A **Collaborator**=The study will take place at the Rotana Cove Resort Ras Al Khaimah United Arab Emirates. The Rotana Cove Resort is a 5* star resort and as to be expected all facilities, health and safety and staff training are to the highest leisure facility standards. There are optimum health and safety protocols within the recreation spa and swimming pool areas where the study will take place.

15. Other Research Ethics Committee Approval
• Please indicate whether additional approval is required or has already been obtained (e.g. an NHS Research Ethics Committee). • Please also note which code of practice / professional body you have consulted for your project. • Whether approval has previously been given for any element of this research by the University Ethics Sub-Committee.
N/A

16. Purpose of the study
In lay language, please provide a brief introduction to the background and rationale for your study. *[100-word limit]*
Physical activity in the heat results in heat acclimatisation (Tyler, Reeve, Hodges and Cheung, 2016). As such people who regularly participate in sports or routinely work in hotter climates can tolerate the effects of heat to a greater extent (Corbett, Neal, Lunt and Tipton, 2014). Upon immersion to cooler climates, the effects of heat tolerance can be lost (Garrett, Rehrer and Patterson, 2011); (Periard, Travers, Racinais and Sawka, 2016) regardless of physical activity levels (Saat, Sirisinghe, Singh and Tochihara,2005); (Weller, Linnane, Jonkman and

Daanen ,2007). The use of a sauna in conjunction with regular training has been shown to improve performance. (Scoon, Hopkins, Mayhew and Cotter, 2007) As such, the rationale for the current study is that a post exercise sauna in cooler conditions will limit the decay of prior heat acclimatisation . The study is therefore useful to those who spend time way from the heat and have little time if any time to reacclimatise upon return to hotter climates.

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17. Study Design/Methodology

In lay language, please provide details of:

a) The design of the study (qualitative/quantitative questionnaires etc.)
b) The proposed methods of data collection (what you will do, how you will do this and the nature of tests).
c) You should also include details regarding the requirement of the participant i.e. the extent of their commitment and the length of time they will be required to attend testing.
d) Please include details of where the research/testing will take place, including country.
e) Please state whether the materials/procedures you are using are original, or the intellectual property of a third party. If the materials/procedures are original, please describe any pre-testing you have done or will do to ensure that they are effective.

A) The design of the study (qualitative/quantitative questionnaires)

The purpose of this study is to investigate how the intervention of a sauna in conjunction with regular training in cooler conditions may help to limit the decay of the beneficial physiological markers attained through prior heat acclimatisation.

The study will take place over the duration of a 2 months with a focus on a set of 8-10 participants at one time from a cohort of 26-30 in total. The sample size has been calculated using a G-power sample size calculation on the following premise:

F -test based on a one -way between ANCOVA

Effect size=1.20 Number of groups=2

Significance =0.05 Number of measurements=6

Power=0.95

Actual power= 0.9562

Sample size =26

Allocation of Participants and Duration of Study

Primarily the researcher shall attain physiological markers of performance and heat acclimatisation over the course of th e first week (7 days) of the study in regular UAE hot humid conditions for the time of year. Within the first week of the stud y the participants will participate in their usual training routines and a sports specific fitness test. The researcher will o nly work with 2 participants at one time from a group of 8-10 to allow accurate recording of physiological data and due care and attention to those who partake in the sauna intervention group. The participants work schedule allows the study to be scattered over the duration of late afternoon to early evening, encompassing all participants. During the study training protocol which will last 14 days participants will train three times a week, albeit on varying days to suit their lifestyle demands.

A maximum of 2 participants will train together at any one time, all participants will train in the same gym with the same temperature control. Participants who are participating in the sauna intervention will enter the sauna within the first 5 minutes after their gym-based training session. The length of time spent in the sauna will be 20 minutes.

Upon immersion to regular outdoor training conditions (last 7 days) participants will partake in 2 routine training sessions and a repeat of the preliminary sports specific fitness.

Throughout the study, participants physiological measurements will be taken at 5-minute intervals whilst in the gym and outdoor environments. Equally, physiological data shall be recorded at 5-minute intervals for participants immersed in the post exercise sauna. Before and after training, participants in the gym based alone training group shall measure bodyweight in their regular training kit. Participants immersed in the post exercise sauna group will record their post exercise bodyweight after immersion to the sauna in their regular kit. Bodyweight will also be recorded during the first and last week of the study with participants wearing regular training kit. All participants will be able to drink ad libitum throughout the entirety of the study, the researcher will record the total amount drunk to account for sweat rate. After the cooler gym condition study interventions, participants will simultaneously be reintroduced to training in the heat after one rest day.

The study will purposely start in February 2018 to coincide with a distinct rise in temperature in the United Arab Emirates (UAE) after the relatively cool winter months of December and January. Before immersion to training in cooler conditions, participants will partake in their usual training regime in the heat. The participants daily thermal load consists of a sports training regime based upon a sports specific fitness and tactics for a duration of towards two hours, at a frequency of three times a week. The participants usual training sessions are performed in the late afternoon and early evening where regular time of year temperatures are within the range of 20-28 degrees centigrade during the cooler months. During the late summer and late spring months it would not be unusual for participants to train and compete in temperatures within the range of 28-35 degrees centigrade. All the participants have lived in the UAE for at least a period of two months. Furthermore, several of the participants are employed in the sports education sector and as such are immersed to the outdoor hot sunny UAE climate for at least two hours a day at work, albeit not always engaged in physical activity.

Physiological markers of heat acclimatisation such as tympanic temperature, heat rate, sweat rate and actual fitness testing performance will be measured within the first 7 days of the study, before training in cooler conditions. With exception of fitness testing performance, physiological markers will continue to be measured during intermittent train ing sessions in cooler conditions set over 14 days; and measured upon reintroduction to the heat at days 21-28 of the study alongside a further measurement of fitness testing performance.

Prior to starting the study, the researcher will test all physiologi cal measurement equipment and fitness equipment that is to be used upon the participants. Prior testing of equipment is to ensure that it is reliable and that participants are familiar with how to correctly use the gym based exercise equipment; in this instance a treadmill. Secondly, the researcher shall present a short seminar to the participants and their coach (where applicable) upon the purpose of the study and the global merits of the study linked to their sports and occupational needs . During the seminar participants will be exposed to qualitative measurement tools such as rate of perceived exertion scales (Borg, 1998) and a thermal sensation tool; the ASHRAE thermal sensation scale. The purpose of pre study exposure to the qualitative measurement to ols is to ensure that participants are familiar with the concept of each scale and how to apply the scale to their perception of feelings in preparation for the stu dy ahead.

B) The proposed methods of data collection (what you will do, how you will do this and the nature of tests).

Heart Rate

To measure heart rate participants shall wear a Polar branded water resistance heart rate monitor. A heart rate strap shall b e worn around the mid torso and a Polar watch worn on the wrist on which to read heart rate measurements. The researcher will ensure that the monitor works reliably prior to the study and with each participant during the study.

Tympanic Temperature

Tympanic temperature will be recorded using a standard medical tympanic temperature gauge. To ensu re safety, participants will be informed that any contraindications such as ear infections will not be suitable for tympanic measurement and as such they may withdraw or wait until infections heal.

Sweat rate

All participants shall measure their body weight before training in their regular training clothes. Upon cessation of training or training with a post exercise sauna, participants shall re measure their body weight in regular gym clothes. The weight of th e gym clothes pre-and post exercise and volume of water drunk shall be accounted for to calculate sweat rate. To measure bodyweight a physician's DETECKO office weighting scale will be employed to record weight for all participants.

Fitness Performance

Participants shall partake in a standard sports related fitness test as part of their regular training routine. The test usually encompasses a sports specific time trial using a running based endurance test such as a Cooper test. The same test will be used pre and post study intervention. All participants are used to the rigor of the sports fitness testing protocol.

Sauna

A TYLO dry heat sauna with a digital thermostat set at 75-80 degrees centigrade will be used for participants in the post exercise sauna intervention. At all times qualified resort spa staff are on duty to maintain and oversee health and safety of all spa related equipment. There is a safety alarm in the dry heat sauna and a water dispenser within 5 meters that is thoroughly maintained and equipped to resort standards.

Treadmill

A TechnoGym recreational treadmill will be used for gym based cooler training conditions. All gym equipment is regularly maintained and calibrated to resort recreational standards. There are two treadmills in the resort gym, as such participants may train on both to ensure that there is no training effect due to any differences in calibration between treadmills.

Training Intervention

Intensity of training sessions will be based upon recorded heart rates throughout the sports related fitness test in the firs t week of the study. For example; a training intensity of 75% maximal heart rate (MHR) may be prescribed. using preliminary sports fitness testing performance heart rate measurements. Control over treadmill intensity will be set via speed and gradient to ensure 75% is achieved for each individual participant. As such, the training intervention will be set according to participants individual fitness (MHR) level. Whilst the preliminary sports fitness test may not achieve a MHR reading, the fitness test will demand absolute maximal effort and as such is a good measure of high intensity effort related to heart rate. The training intervention will last towards the duration of 30 minutes which will be a blend of continuous and interval-based treadmill exercise sessions. Participants in the post exercise sauna intervention will only need to travel across a small hallway to the sauna room which is adjacent to the gym. Participants will reside in the dry heat sauna for the duration of 20 minute s post exercise, drinking ad libitum. Control for cooler conditions in the gym is thermostatically controlled by a global hotel resort air conditioning system that is regularly maintained and monitored in line with the harsh and hot environmental demands in the United Arab Emirates. The temperature in the gym environment is set at 15 -18 degrees centigrade or lower if desired. Humidity will be variable, although this is as per the norm in regular environmental conditions in the United Arab Emirates. Whilst participants train in conditions set at 15-18 degrees; outside temperatures will be upward of 25 -30 degrees.

Qualitative Feedback

Throughout the training interventions participants will report their perceived rate of exertion and perceived rate of thermal sensation at 5 minute intervals in line with other physiological measurements. Prior to the training intervention all participants will have been exposed to the Perceived Rate of Exertion (Borg,1998) and ASHRAE thermal sensation scales with regards to understanding of terminology and usage during exercise.

BORG, G., P. HASSMEN, and M. LANGERSTROM. (1998). Perceived exertion overtraining:

Influence of a defined increase in training volume vs related to heart rate and blood lactate

during arm and leg exercise. training intensity on performance, catecho1amines and some met-European. Journal of. Applied. Physiology. 65:679-685

18. Participants

Please mention:

a) The number of participants you are recruiting and why. For example, because of their specific age or sex.
b) How they will be recruited and chosen.
c) The inclusion/exclusion criteria.
d) For internet studies please clarify how you will verify the age of the participants.
e) If the research is taking place in a school or organisation then please include their written agreement for the research to be undertaken.
f) Please state any connection you may have with any organisation you are recruiting from, for example, employment.

A) 26-30 male participants aged 21-45 will be recruited for the study in line with a suitable sample as calculated with reference to the G-Power sample size calculation.

B) All participants will be recruited from a professional sports occupational work force based in the local region. The recruitment process will be an approach to sports teachers known to the lead researcher, an amateur Gaelic Football Team and professional footballers via the UAE Emirates Premier league club professional coaching staff who are also acquainted with the lead researcher. All participants will be informed of the nature of the study by way of a seminar The choice of participants is based upon their need to participate regularly in outdoor hot conditions in the UAE. As such, the participants serve as ideal candidates on which to assess the effects of a sauna intervention when training in the cool alone to help preserve performance for the heat.

C) Any participant who is not able to participate due to prolonged contraindications such as injury, illness or other stress factors will be excluded from the study. Exclusion criteria will be achieved by way of a PAR-Q which will assess participants current and previous health status. All others as deemed healthy by self-declaration will be included in the study. A participant will have the right to withdraw from the study at any time due to incidence of illness, injury or other contraindications.

D) N/A

E) The study will take place at the Rotana Cove Hotel Resort in Ras Al Khaimah United Arab Emirates. A written agreement from the executive general manager is included in the ethics form. The executive general manager is responsible for the entirety of the hotel resort, as such his decision is final.

F) The only connection the lead researcher has with the organisation is a home based upon the resort and as such familiarisation with the management and all staff alike.

19. Consent
If you have any exclusion criteria, please ensure that your Consent Form and Participant Information Sheet clearly makes participants aware that their data may or may not be used. a) Are there any incentives/pressures which may make it difficult for participants to refuse to take part? If so, explain and clarify why this needs to be done b) Will any of the participants be from any of the following groups? ➢ Children under 18 ➢ Participants with learning disabilities ➢ Participants suffering from dementia ➢ Other vulnerable groups. c) If any of the above apply, does the researcher/investigator hold a current DBS certificate undertaken within the last 3 years? A copy of the DBS must be supplied separately from the application. d) How will consent be obtained? This includes consent from all necessary persons i.e. participants and parents.
A) The only persuasive incentives for participants is free access the Cove Rotana Resort for a period of one month. Otherwise, interest in the outcome of the study is linked to the participants professional and personal fitness training strategies. It had been considered that participants may feel pressured to take part due to their acquaintance with the lead researcher. However, as discussed above, any contraindications be it medical or mental would allow participants to withdraw from the study. Secondly, the study will largely represent the regular volume and intensity of the participants normal training routine, albeit it in a different environment. B) N/A C) N/A D) Consent will be obtained by way of a consent form included at the end of the ethics form. All participants will have prior knowledge of the purpose of the study by way of a seminar delivered to participants.

20. Risks and benefits of research/ activity
a) Are there any potential risks or adverse effects (e.g. injury, pain, discomfort, distress, changes to lifestyle) associated with this study? If so please provide details, including information on how these will be minimised. b) Please explain where the risks / effects may arise from (and why), so that it is clear why the risks / effects will be difficult to eliminate or minimise. c) Do you have an approved risk assessment form relating to this research? d) Does the study involve any invasive procedures? If so, please confirm that the researchers or collaborators have appropriate training and are competent to deliver these procedures. Please note that invasive procedures also include the use of deceptive procedures to obtain information. e) Will individual/group interviews/questionnaires include anything that may be sensitive or upsetting? If so, please clarify why this information is necessary (and if applicable, any prior use of the questionnaire/interview).

f) Please describe how you would deal with any adverse reactions participants might experience. Discuss any adverse reaction that might occur and the actions that will be taken in response by you, your supervisor or some third party (explain why a third party is being used for this purpose).

g) Are there any benefits to the participant or for the organisation taking part in the research?

A) There are always risks associated with any form of exercise such as muscle strains and ligament sprains. However, all participants in the study are used to a regular training routine in line with their occupational needs. Secondly, at all times the fitness training environment will be monitored by qualified fitness personnel, whilst the participants will train under close supervision from the lead researcher who is a qualified personal trainer and a final year St Marys University MSc student in strength and conditioning. Studies (Hannuksela and Ellahham, 2001) confirm that the risk of sauna usage linked to acute myocardial infarctions or even sudden death are rare in normal healthy populations. The current study will ensure that all participants drink ad libitum and are able to leave the sauna if feeling any signs of distress or discomfort. Secondly all participants will be monitored on a one to one basis via the lead researcher who will be based directly outside the sauna and will take physiological markers linked to heart rate, tympanic temperature and psychosomatic markers linked to thermal sensation at regular 5-minute intervals. All participants in the study work and compete outside in the United Arab Emirates, at times towards 10 hours a day. Average temperatures in the United Arab Emirates during the summer months are 36 degrees centigrade whilst average winter temperatures approach towards 20 degrees centigrade. As such all participants are used to hot adverse weather conditions.

B) Any immediate risks that may occur during the study are the effects of heat upon the participants during the post exercise sauna. As described above, the sauna environment has an abundance of water, two cold water showers, professional spa personnel and first aid personnel. The participants can withdraw at any stage during the study. Finally, the entirety of the Sauna spa area is air conditioned; therefore, in the event of distress participants can immerse themselves in cool conditions with immediate effect. It is felt by the lead researcher that whilst potential negative post exercise sauna heat effects can not be completely discounted, the safe environment surrounding the sauna alongside the ability for participants to withdraw creates a safe platform on which to study the effects of a post exercise sauna in limiting prior heat acclimatisation decay in the current study.

C) Professional risk assessments are routinely performed as part of the day to day infrastructure at the hotel resort. Resort risk assessments include an overview of all exercise equipment, spa facilities including the sauna, outdoor pool facilities, beach facilities and professional practice by all personnel at the resort.

D) The only invasive procedures in the current study are linked to obtaining tympanic temperature via the ear and the recording of sweat rate. At all times the measurement of tympanic temperature will take place in the public eye with little if any potential harm to participants other than contraindications that would prevent a tympanic temperature reading. Sweat rate will equally be measured in the public eye, participants will not record nude body weight, instead the weight of their regular gym clothes will be recorded and considered for an accurate sweat rate calculation. All changing facilities are in the recreational spa area and allow privacy always whilst participants change in and out of their regular gym clothes. Equally the sauna area presents two private changing areas that can be used by participants.

E) All qualitative measurements linked to thermal sensation and rate of perceived exertion do not present any sensitive or upsetting content for participants.

F) In the event of an adverse reaction to heat or exercise all activities will cease immediately, a first aider may be called , and drink or medical intervention is at hand. If a severe adverse reaction may take place the resort is well equipped to deal with emergency response due to the capacity to deal 1000+ visitors to the resort at any one time.

G) The rationale of the study seeks to investigate the effectiveness of the intervention of a post exercise sauna in cooler climates whilst away from usual hotter temperatures to maintain heat tolerance. Thus, the outcome of the study may benefit the hotel resort Lifeguards and fitness training staff who take an annual holiday at towards a month or more which is generally based in cooler climates than the United Arab Emirates. All Lifeguards and fitness staff need to be ready to function

to maximum physical capacity upon return from holiday regardless of extreme heat. As such, a post exercise sauna in cooler climates whilst on holiday may help to maintain their ability to readily function at maximal physical capacity upon their return from holiday. For external parties linked to the study the results may provide a simple and effective strategy for footballer s to maintain the positive effects of heat acclimatisation whilst competing in cooler climates for prolonged periods of time. For UAE sports teachers who routinely travel to northern Europe during the summer months in the UAE the study may also highlight the effectiveness of a post exercise sauna intervention to maintain occupational readiness for return to the UAE. The rationale of the study is therefore useful to a wide cohort of professions and sports people based in the hot climates. Hannuksela, M.L., and Ellahham, S. (2001). Benefits and risks of sauna bathing. American Journal of Medicine. 110(2) 118-26.
21. Confidentiality, privacy and data protection
• What steps will be taken to ensure participants' confidentiality? • Please describe how data, particularly personal information, will be stored (please state that all electronic data will be stored on St Mary's University servers). • *If there is a possibility of publication, please state that you will keep the data for a period of 10 years.* • Consider how you will identify participants who request their data be withdrawn, such that you can still maintain the confidentiality of theirs and others' data. • *Describe how you will manage data using a data a management plan.* • *You should show how you plan to store the data securely and select the data that will be made publicly available once the project has ended.* • *You should also show how you will take account of the relevant legislation including that relating data protection, freedom of information and intellectual property.* • Who will have access to the data? Please identify all persons who will have access to the data (normally yourself and your supervisor). • Will the data results include information which may identify people or places? • Explain what information will be identifiable. • Whether the persons or places (e.g. organisations) are aware of this. • Consent forms should state what information will be identifiable and any likely outputs which will use the information e.g. dissertations, theses and any future publications/presentations.
All participants will only be identifiable by initials only. Upon accruing data it will be stored electronically on a passwor d protected United Arab Emirate government protected PC. At all times the PC is at hand to the lead researcher or stored securely in a private house based at the resort where the study will take place. The resort has a security guard team and cameras. Only the lead researcher has a key to the private house and will know the password to the PC. In the event of potential publication all data will remain electronically on the PC or instead be transferred to a lead researchers external drive that will be stored in a private house either in the United Arab Emirates or the UK. If a participant requires to be withdrawn, their details via identifiable initials shall be permanently deleted whilst all other data for participants shall remain intact. The participant will be informed that their data has been deleted. In line with Freedom of Information Act (2000) all participants will have the right to access any information about themselves linked to psychophysiological data relevant to the study. Two people will have access to the data throughout the study; the lead researcher and the University supervisor. There is no harm that can be done via knowledge of the data to any of the first or second parties involved in the study. The information available will be; heart rate measurements, tympanic temperature, sweat rate, perceived rate of exertion, thermal sensation and time trial performance scores. All participants in the study and the organisation they work for will be aware of who has privy to the psychophysiological markers and performance scores attained during the study. Consent forms will inform participants of which data will be pertinent throughout the study and how it may be made publicly available in the future.
22. Feedback to participants

Please give details of how feedback will be given to participants:

- As a minimum, it would normally be expected for feedback to be offered to participants in an acceptable to format, e.g. a summary of findings appropriately written.
- Please state whether you intend to provide feedback to any other individual(s) or organisation(s) and what form this would take.

Throughout the duration of the study participants shall be verbally informed of their performance and their physiology measurements throughout training. The intention is to help motivate participants to work to their usual capacity throughout the duration of the study by way perceived exertion feedback and physiological data feedback.

Upon completion of the study the lead researcher proposes to compile a summary of findings for the professional football coaching staff, sports teachers, amateur athletes and the hotel resort management. The summary of findings shall be based in layman terms which shall include psychophysiological markers liked to participants who had a post exercise sauna and psychophysiological markers linked to the participants who trained in the cooler gym conditions alone. Whilst the study is based in the UAE, all participants are first language English speakers or at least have a strong understanding of English as a second language.

The proposer recognises their responsibility in carrying out the project in accordance with the University's Ethical Guidelines and will ensure that any person(s) assisting in the research/ teaching are also bound by these. The Ethics Sub-Committee must be notified of, and approve, any deviation from the information provided on this form.

Signature of Proposer(s) James Coe	Date: 16th January 2018
Signature of Supervisor (for student research projects) Mark Waldron	Date: 16th January 2018

St Mary's University Twickenham London

19 January 2018 SMEC_2017-18_053

James Coe (SHAS): 'Effect of using a sauna to limit heat acclimatisation decay in cooler climates'

Dear James

University Ethics Sub-Committee

Thank you for re-submitting your ethics application for consideration.

I can confirm that all required amendments have been made and that you therefore have ethical approval to undertake your research.

Yours sincerely

Conor Gissane

Prof Conor Gissane
Chair, Ethics Sub-Committee

Cc Dr Mark Waldron

Participant Information and Consent Form

Mr James Coe

18 The Cove Rotana

Ras Al Khaimah

United Arab Emirates

Telephone number: 0971569515418

Email: jccoe2007@yahoo.co.uk

Date 15th November 2017

Dear Participant,

As a full time, occupational fitness professional who is required to work in a hot climate you have been s elected to take part in a study that will examine the effect of using a post exercise sauna to limit heat acclimatisation decay in cooler climates. Please find attached the participant information sheet that provides detail on what the study involves, the time commitment required and the benefits to participating.

Please take whatever time you need to discuss the study with your colleagues and supervisor where applicable. The decision take part in the study is up to you. Please do not hesitate to contact me if you have any questions concerning the study.

Kind regards,

James Coe

Section A: The Research Project

1. Effect of using a sauna to limit heat acclimatisation decay in cooler climates

2. Purpose and value of study

Training in the heat has shown to have several physiological benefits linked to lower heart rate, core temperature and sweat rate at a given intensity. Furthermore, the effects of heat acclimatisation have shown to improve performance in the heat an d cooler conditions. However, the physiological benefits from training in the heat have also been shown to be temporary and may show signs of decay at periods ranging from as little as 4 days and complete decay towards 28 days. As such, it would be useful to consider interventions that may limit the rate of heat acclimatisation decay when athletes and occupational personnel reside away from the heat. Subsequently, on return to hotter climates athletes and occupational personnel may be more well equipped and ready to perform without the need for rigorous heat acclimatisation strategies before sports or work-related performance. The intervention of a post exercise sauna has shown favorable benefits linked to physiological markers of heat tolerance. As such, the study will consider the efficacy of a post exercise sauna intervention in contrast to regular training alone to limit the decay of prior heat acclimatisation physiological performance benefits.

3. Invitation to participate

You have been selected to participate in the study due to your occupational fitness requirements to be able to perform at a consistently high standard in the heat in your role as a fitness professional in the United Arab Emirates. During holiday pe riods that may stem towards one month you are largely away from the hot climates of the United Arab Emirates. As such, a post exercise sauna in line with your regular training routine whilst on holiday may assist in maintaining heat related fitness performance for your occupational needs on return to the heat of the United Arab Emirates.

4. Who is organising the research

The research is to be organised by the lead researcher who will be guided by a supervisor based at St Mary's University Twickenham London. The Rotana Cove Hotel Resort Ras Al Khaimah, United Arab Emirates will assist in the research via the provision of fitness and spa resources for all participants.

5. What will happen to the results of the study

The results of the study will form part of a MSc thesis in strength and conditioning base d at St Mary's University Twickenham London. Results will be displayed visually via a poster presentation at the University and discussed in detail via a viva presentation to academic staff at the University. All results will be kept securely on the lead researcher's PC which is protected by United Arab Emirate Government security. In the likelihood of publication, results will be presented in a scientific journal related to the field of strength and conditioning. At all times participants personal details will be confidential and all participants will access to any publication.

6. Source of funding for the research

St Mary's University Twickenham London will provide any funding that may be applicable for the research project. The lead researcher may also contribute to research resources from their own budget.

7. Contact for further information

The lead researcher is the principal contact for the study. Contact details are as follows:

James Coe

0971569515418

18 The Cove Rotana

Ras Al Khaimah

United Arab Emirates

Jccoe2007@yahoo.co.uk

The contact details for the project supervisor are as follows:

Dr Mark Waldron

St Mary's University Twickenham London

mark.waldron@stmarys.ac.uk

Section B: Your Participation in the Research Project

1. Why you have been invited to take part

You have been invited to take part in the above research project as you have ideal occupational fitness requirements related to the purpose of the study.

2. Whether you can refuse to take part

You have the right to not take part in the study for any reason that may make you feel uncomfortable or any personal circumstances that may prevent your participation.

3. Whether you can withdraw from the project at any time, and how

If at any time you feel uncomfortable for any reason during the study, you have the right to withdraw. To withdraw you simply need to inform the lead researcher who will withdraw your participation and delete all records associated with your participation in the study.

4. What will happen if you agree to take part (brief description of procedures/tests)

Participation in the study will involve completion of your regular training and a time trial performance work related test as set by your work place supervisor.

During training in cooler conditions, you will be required to train in the gym with temperature-controlled air conditioning. Training will be based upon a treadmill. Physiological markers will be heart rate; that will require the wearing of a heart rate monitor and watch. For core temperature an ear lobe tympanic temperature tool will be used that is inserted into the ear lob e for a brief period to attain a temperature reading. Sweat rate will be recorded via bodyweight measurement in regular gym clothes and a record of fluids drunk throughout fitness training and performance. For participants who partake in the post exercise sauna conditions it will be necessary to sit passively in a dry heat sauna for 20 minutes. The dry heat sauna will be thermostatically controlled at a temperature of 75-80 degrees centigrade. The duration of the study will be for one month for each participant. For a period of 18 days in the one-month period you will be required to ONLY train in cooler conditions before the reintroduction to training in regular hotter climates in the final week of the study. You will be required to maintain your regular training and fitness routine throughout the duration of the study and largely avoid alcohol and any other substances that may contravene the results of the study.

5. Whether there are any risks involved (e.g. side effects) and if so, what will be done to ensure your wellbeing/safety

Primary identified risks may be inverse heat side effects linked to the post exercise sauna. At a ll times you will be able to drink to thirst and leave the sauna if you feel uncomfortable. Secondly, the lead researcher will be with participants always durin g time spent in the sauna. Regular fitness professional and first aid staff will on site always and in close proximity to participants in the sauna.

6. Whether there are any special precautions you must take before, during or after taking part in the study

There are no special precautions participants need to take other than maintain a healthy lifes tyle throughout the duration of the study. Participants should also be aware of any infections linked to the ear that may arise during the study and therefo re prevent a tympanic temperature reading.

7. What will happen to any information/data/samples that are collected from you

All participant results will be collected and stored securely on a United Arab Emirates Government PC that is only accessible via the lead researcher's password. Results will be presented visually and aurally at St Mary's Universit y Twickenham London. At all times participants shall remain anonymous to all members of the public.

8. Whether there are any benefits from taking part

The key benefit to taking part in the research is to research the efficacy of a post exercise sauna intervention in cooler conditions in relation the maintenance of prior heat related performance benefits. It is hoped that the study will highlight how athletes and occupational personnel who need to perform regularly in the heat can use the simple cost-effective intervention of a post exercise sauna to subsequently lessen the need for rapid heat acclimatisation strategies upon return to the heat.

9. How much time you will need to give up taking part in the project

You will not need to give up any personal time for the duration of the study. The only requirement is to maintain your regular training regime, albeit in hot and cooler conditions. Participants who partake in the sauna intervention may be required to train slightly longer than their regular training sessions.

10. How your participation in the project will be kept confidential

All participants shall only be identified by initials and numbers throughout the duration of the study. Participant data shall be kept securely on a United Arab Emirate Government PC with a secure password only known to the lead researcher

YOU WILL BE GIVEN A COPY OF THIS FORM TO KEEP TOGETHER WITH A COPY OF YOUR CONSENT FORM

St Mary's University Twickenham London

Name of Participant: ____

Title of the project: **Effect of using a sauna to limit heat acclimatisation decay in cooler climates**

Main investigator and contact details: James Coe; Telephone number – 0971569515418; Email – jccoe2007@yahoo.co.uk

1. I agree to take part in the above research. I have read the Participant Information Sheet, which is attached to this form. I understand what my role will be in this research, and all my questions have been answered to my satisfaction. 2. I understand that I am free to withdraw from the research at any time, for any reason and without prejudice. 3. I have been informed that the confidentiality of the information I provide will be safeguarded. 4. I am free to ask any questions at any time before and during the study. 5. I have been provided with a copy of this form and the Participant Information Sheet.

Data Protection: I agree to the University processing personal data, which I have supplied. I agree to the processing of such data for any purposes connected with the Research Project as outlined to me.

Name of participant (print)………………………….. Signed……………….………Date……………

Name of witness (print)……………………………Signed……………………….Date……………….

If you wish to withdraw from the research, please complete the form below and return to the main investigator named above.

Title of Project: **Effect of using a sauna to limit heat acclimatisation decay in cooler climates**

I WISH TO WITHDRAW FROM THIS STUDY

Name: ____

Signed: ______________________________ Date: __________________

Study Premises Consent Letter

Study Premises Letter

Resort – Ras Al Khaimah

Date: 29th November 2017

Place: Ras Al Khaimah

To whom it may concern,

This is letter is to inform that we hereby grant access to the premises of "The Cove Rotana Resort" to Mr. James - COE to conduct his heat acclimation study which is due to commence in February 2018.

Detailed information will need to be sent by Mr. James COE to my attention by no later than the 21st of January 2018 outlining the specific dates, duration, number of participants and facilities needed for the study in order to make necessary arrangements.

We have also received Mr. James - COE's assurance that all visiting participants will adhere at all time to the code of conduct stipulated in our Resort.

I remain at your complete disposal should you require further assistance.

Warmest Regards,

Erik Guluta

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Perceptual Data Screening Measures

Effect of using a sauna to limit heat acclimatisation decay in cooler climates

Appendix

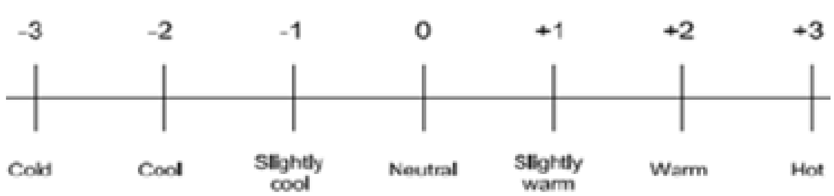
A Rate of Perceived Exhaustion Borg Scale.

Source: Borg G.A. Psychophysical bases of perceived exertion. *Medicine and Science in Sports and Exercise*. 1982; 14:377-381.

Rating	Perceived Exertion
6	No exertion
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

B ASHRAE 7 Points Thermal Sensation Scale

Source: Beizaee, A., Firth, S., Vadodaria, K. and Loveday, D. (2012). Assessing the ability of PMV model in predicting thermal sensation in naturally ventilated buildings in UK. Proceedings of 7th Windsor Conference*: The Changing Context of Comfort in an Unpredictable World*.



March Study Group Data

March (27deg)	Pre gym and sauna	Hr	Tt	Sw	RPE	Thermal	Distance
Irish 39yr Tri	1	159.75	34.45	0.3	16.5	2	4868.5
asian 49yr Sc	2	175.75	36.05	0.25	13	0.5	2731.5
arab 21yr Sc	3	156.75	35.35	0.4	13	-0.5	4096.5
african 19yr Cf	4	184.75	36.175	0.8	13	-0.5	3800
english 22yr Sc	5	170	35.875	0.35	17	2	4096.5
		164.875	35.1625	0.325	16.75	2	4482.5
		7.247845	1.007627	0.035355	0.353553	0	545.8864
March (29deg)	Post gym and sauna	Hr	Tt	Sw	RPE	Thermal	Distance
Irish 39yr Tri	1	150	36	0.6	16	2	4875
asian 49yr Sc	2	167	35.9	0.4	14	1	2925
arab 21yr Sc	3	152	35.8	0.7	13	3	4225
african 19yr Cf	4	184	36.4	0.9	10	0	4225
english 22yr Sc	5	169	36.4	0.5	12	2	3900
		159.5	36.2	0.55	14	2	4387.5
Sports Key		13.43503	0.282843	0.070711	2.828427	0	689.4291
Tri=triathlon							
Sc=Soccer							
Cf=Crossfit							

March (27deg)	Pre gym	Hr	Tt	Sw	RPE	Thermal	Distance
English 34yr Cf	1	163	35.975	0.4	19	3	4387
Arabic 21yr Sc	2	191	35.45	0.2	11.5	-0.5	3206
Scottish 28yr Sc	3	189.5	36	0.35	15.5	1	4156
German 43 yr Tri	4	168.25	34.8	0.65	15	-0.5	3800
		165.625	35.3875	0.525	17	1.25	4093.5
		3.712311	0.83085	0.176777	2.828427	2.474874	415.0717
March (29deg)	Post gym	Hr	Tt	Sw	RPE	Thermal	Distance
English 34yr Cf	1	160	36.2	0.5	19	3	4225
Arabic 21yr Sc	2	189	36.2	0.5	15	1	3250
Scottish 28yr Sc	3	170	35.8	0.7	13	1	3900
German 43 yr Tri	4	160	35.8	0.8	16	1	3900
		160	36	0.65	17.5	2	4062.5
Sports Key		0	0.282843	0.212132	2.12132	1.414214	229.8097
Tri=triathlon							
Sc=Soccer							
Cf=Crossfit							

April Study Group Data

April (32deg)	Pre gym and sauna	Hr	Tt	Sw	RPE	Thermal	Distance
English 27yr Sc	1	170.25	36.95	0.55	15	1.5	4550
English 21yr Sc	2	166.5	35.95	0.8	14.5	1	3737.5
English 23yr Sc	3	162.5	36.5	0.45	15	1	3625
USA 39yr Run	4	164	36.15	0.45	16	1.5	3900
English 26yr Sc	5	175	36.55	0.75	17.5	2	3900
		172.625	36.75	0.65	16.25	1.75	4225
		3.358757	0.282843	0.141421	1.767767	0.353553	459.6194
April (36deg)	Post gym and sauna	Hr	Tt	Sw	RPE	Thermal	Distance
English 27yr Sc	1	161.75	36.75	0.4	15.5	1	4712.5
English 21yr Sc	2	154.5	36.6	0.55	14	1	3737.5
English 23yr Sc	3	153.5	36.4	0.75	15	2	3737.5
USA 39yr Run	4	170	36.55	0.5	17	2	4062.5
English 26yr Sc	5	169	36.4	0.55	16	1.5	3997.5
		165.375	36.575	0.475	15.75	1.25	4355
Sports Key		5.126524	0.247487	0.106066	0.353553	0.353553	505.5813
Run							
Sc=Soccer							
Gf=Gaelic Foot							

April (32deg)	Pre gym (32 deg)	Hr	Tt	Sw	RPE	Thermal	Distance
Irish 39yr Run	1	176	36.4	0.7	14	0	4062
English 34yr Sc	2	173.5	36.65	0.5	13	1.5	3575
Indian 30yr Sc	3	170.25	36.8	0.65	16.5	2	4550
English 47yr Sc	4	161	35.95	0.75	16.5	3	4225
Irish 51 yr Gf	5	160	36.7	1	15	2.5	3700
English 35yr Sc	6	191.25	36.75	0.75	15	1.5	4712
		183.625	36.575	0.725	14.5	0.75	4387
		10.78338	0.247487	0.035355	0.707107	1.06066	459.6194
April (36 deg)	Post gym (36 deg)	Hr	Tt	Sw	RPE	Thermal	Distance
Irish 39yr Run	1	177.5	36.9	0.7	15	1	4225
English 34yr Sc	2	170	36.6	0.45	17.5	2	3575
Indian 30yr Sc	3	154.5	36.6	0.4	16	2	4387.5
English 47yr Sc	4	157.25	36.77	0.95	17.5	3	4550
Irish 51 yr Gf	5	157	36.65	0.85	14	2	3900
English 35yr Sc	6	172	37.3	0.75	18	3	4875
		174.75	37.1	0.725	16.5	2	4550
Sports Key		3.889087	0.282843	0.035355	2.12132	1.414214	459.6194
Run							
Sc=Soccer							
Gf=Gaelic Foot							

Sauna Exposure Data

March Sauna Participants

	Hr	Tt
Irish 39yr Tri	117	37
asian 49yr Sc	139	37
arab 21yr Sc	118	37
african 19yr Cf	123	39
english 22yr Sc	129	37
	123	37
	8.485281	0
Sports Key		
Tri=triathlon		
Sc=Soccer		
Cf=Crossfit		

April Sauna Participants

	Hr	Tt
English 27yr Sc	143	39
English 21yr Sc	125	40
English 23yr Sc	118	38
USA 39yr Run	138	39
English 26yr Sc	141	38
	142	38.5
	1.414214	0.707107
Sports Key		
Run		
Sc=Soccer		
Gf=Gaelic Foot		